第39卷 第3期
2001年 7 月

古 脊 椎 动 物 学 报
VERTEBRATA PALASIATICA

pp.185～196
pls.I～II

新疆准噶尔盆地北缘始新世 *Advenimus* 梳趾鼠类一新种[1)]

孟 津[1] 吴文裕[2] 叶 捷[2]

(1 美国自然历史博物馆 纽约 10024)

(2 中国科学院古脊椎动物与古人类研究所 北京 100044)

摘要 依据采自新疆福海县哈拉玛盖乡萨尔多依腊地点第三系的化石，建立了一个啮齿类新种乌伦古河陌生鼠 *Advenimus ulungurensis* sp. nov.. *A. ulungurensis* 为一中等大小的早期梳趾鼠类，齿低冠，下齿列颊齿由前向后逐渐增大；上、下第 4 前臼齿均次臼齿化；P4 具发育的前齿带，前、后尖发育但紧相邻，分别以完整的原脊、后脊与原尖相连。M2 前齿带亦发育，前、后尖与分别连接它们的原、后脊无明显界限，不具小尖，次尖小于原尖。下颊齿齿尖较钝。p4 跟座较三角座宽；下臼齿下外脊和下中尖弱；下次脊弱，伸至下次小尖前基部。眶前孔据推测较大。与其他早期梳趾鼠相比，新疆标本与发现于内蒙古、湖北以及吉尔吉斯的 *Advenimus* 最为接近。在已确认的 *Advenimus* 的两个种中，*A. ulungurensis* 在 p4 跟座宽于三角座且缺前齿带，颊齿齿尖较钝、下后尖前倾、下次脊弱且伸至下次小尖前基部、下中尖较弱、跟座开阔等特点方面有别于 *A. burkei*。以齿尖较纤细，下后尖前倾，下原尖后臂弱，下中尖弱小，下次尖与下次小尖连接较强等与 *A. hupeiensis* 相区别。*Advenimus* 原来的两个种都仅以下齿列为依据。产于吉尔吉斯的 *Advenimus* 标本虽有上颊齿，但其与下颊齿的组合是人为的。新疆的 *Advenimus* 标本为该属中首次在同一个体上、下颊齿同时出现，对该属的牙齿形态提供了新的信息。但新疆标本仍很残缺，不足以对早期梳趾鼠类目前尚不清楚的系统发育关系和混乱的分类体系提出更多的看法。我们也未将新种 *Advenimus ulungurensis* 归入已知的任何一科中。

Advenimus 的已知种均产于早始新世地层中。其中吉尔吉斯的标本还与海相化石共生，时代较为可靠。通过对比，初步认为萨尔多依腊地点产 *A. ulungurensis* 化石的层位大约为早始新世晚期。萨尔多依腊位于准噶尔盆地北缘、乌伦古河南岸哈拉玛盖乡以南 5km 处。地点的地理坐标为 N46°36′，E87°41′。该地区出露大面积的第三纪地层。根据前人的资料和我们在该地区的野外调查，我们判定此地为原新疆 631 地质队建立"乌伦古河组"的剖面地点（见叶捷等，2000）。"乌伦古河组"的时代一直存有争议，新化石的发现，使我们能大体确认产化石层位的时代。虽然"乌伦古河组"的明确界定还需时日，但其含有始新世沉积物这一点目前应无异议。

关键词 新疆福海县，早始新世，啮齿类，*Advenimus*

中图法分类号 Q915.873

---

1) 中国国家自然科学基金项目（编号：49572080，49928202）、中国科学院"九五"重点项目（编号：KZ952-J1-410）、中国国家科学技术部特别支持费（国科基字 [1999]045 号）和美国自然科学基金（编号：DEB—9796038）资助。

收稿日期：2001-03-12

A NEW SPECIES OF *ADVENIMUS* (RODENTIA, MAMMALIA) FROM THE EOCENE OF NORTHERN JUNGGAR BASIN OF XINJIANG, CHINA

MENG Jin[1] WU Wen-Yu[2] YE Jie[2]

(1 *Department of Vertebrate Paleontology, American Museum of Natural History* New York NY 10024)

(2 *Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences* Beijing 100044)

Abstract A new species of *Advenimus*, *A. ulungurensis* sp. nov., is described based on dental specimens collected from Tertiary beds on the south bank of the Ulungur River in northern Junggar Basin of the Xinjiang Uygur Autonomous Region of China. These specimens represent the first record of ctenodactyloids in Xinjiang. Correlations with distributions of other species of *Advenimus* indicate that the bed yielding the Xinjiang fossils is of probably early Eocene in age.

Key words Fuhai, Xinjiang, Eocene, rodent, *Advenimus*

1 Introduction

The evolution and systematics of the Tertiary ctenodactyloids have been studied by many workers (Shevyreva, 1976, 1989; Wood, 1977; Dawson et al., 1984; Korth, 1984; Flynn et al., 1986; Wang, 1994, 1997; Averianov, 1996; Tong, 1997; Dashzeveg and Meng, 1998). However, taxonomy and relationships of these endemic Asian species remain unclear and confusing. This situation has been discussed in recent studies (Averianov, 1996; Tong, 1997; Wang, 1997; Dashzeveg and Meng, 1998). This is largely because most of the ctenodactyloid taxa are based on fragmentary materials of primarily dentition. In many cases, upper and lower teeth assigned to one species are associated arbitrarily.

During the field seasons of 1999～2000, some dental and jaw specimens of a ctenodactyloid were collected from Tertiary beds in the vicinity of the Halamagai village on the south bank of the Ulungur River in northern Xinjiang. Although the materials are fragmentary, there are associated upper and lower teeth from one individual. The material represents the first ctenodactyloid recovered from Xinjiang, a new geographic area for early ctenodactyloids. A new species of *Advenimus* is named based on these specimens and is compared with other species previously known from Hubei and Nei Mongol of China, and Kyrgyzstan.

Tertiary beds yielding the specimens are part of the "Ulunguhe Formation", whose age has been controversial, either being considered to be Cretaceous or Eocene–Oligocene. Correlations of the new taxon with other species of *Advenimus* help to clarify the Eocene age of the beds containing the fossils.

2 Systematic paleontology

Ctenodactyloidea Tullberg, 1899

***Advenimus* Dawson, 1964**

***Advenimus ulungurensis* sp. nov.**

Etymology The specific name, *ulungurensis*, is after the name of the Ulungur River.

Holotype IVPP V 12674, partial right and left lower jaws with broken incisors, lateral half of the right p4, complete right m2–3, left m1, left P4, and left M2 from a single individual organism.

Referred specimens IVPP V 12675, a fragmentary right mandible with m1–3; V 12676, a fragmentary left mandible with partial incisor and deeply worn m1–3; V 12677, a fragmentary right mandible with a partial incisor and complete p4–m1; V 12678, a fragmentary left mandible with m2; V 12679, a fragmentary left mandible with m3; V 12680, a fragmentary right mandible with m3; V 12681, a partial rostrum with both incisors; V 12682, a left half of a rostrum with a partial incisor and an associated left m2; V 12683, a left astragalus; and V 12684, a right calcaneus. Although these specimens were collected from a small pit, they bear different stains: some are in dark color, whereas the other in light color. All specimens are housed in the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), Chinese Academy of Sciences, Beijing.

Diagnosis A medium sized ctenodactyloid; cheek teeth low–crowned; lower cheek teeth increasing in size posteriorly; P4 / p4 submolariform; P4 precingulum distinct; P4 metacone and paracone well–developed but closely placed, both cusps connected to the protocone with complete protoloph and metaloph; M2 precingulum distinct, protoloph and metaloph as wide as the paracone and metacone respectively; conules absent; hypocone small; cusps of lower cheek teeth blunt; p4 talonid wider than trigonid; molar ectolophid and mesoconid weak; a weak hypolophid leading to the anterior base of the hypoconulid; infraorbital canal probably large. Differing from *Advenimus burkei* in having p4 talonid wider than trigonid, absence of a precingulum, more blunt cusps on cheek teeth, the metaconid leaning more anteriorly, the hypolophid less–developed and extended to the anterior based of the hypoconulid, the mesoconid smaller, and the talonid basin more open. Differing from *Advenimus hupeiensis* in having less bulbous cusps on cheek teeth, the metaconid more anteriorly extended, the posterior arm of the protoconid weaker, the mesoconid smaller, and the hypoconid–hypoconulid connection stronger.

Locality and age The Sa–er–duo–yi–la locality (N46°36′; E87°41′) yielding the fossils is 5km south to the Halamagai Village, Fuhai County, Xinjiang Uygur Autonomous Region, China. Based on the occurrence of other species of *Advenimus*, the beds of the "Ulunguhe Formation" yielding the specimens are tentatively considered to be of late early Eocene (see Discussion).

3 Description

The upper and lower incisors are transversely compressed and oval shaped in cross section, with the lateral surface being more rounded (pl. I, a). The enamel covers the labial surface of the incisor and wraps around the tooth onto the lateral and medial sides. The enamel has a much more extensive coverage on the lateral side than on the medial side of the tooth. The enamel–dentin boundary on the medial side is distinct, but is less so on the lateral side because of the gradual thinning of the enamel. The lower incisor extends posteriorly within the mandible and ends behind m3 at the level of the tooth row.

It differs from the upper incisor in having a low degree of curvature.

The enamel microstructures were imaged from the lower incisor of V 12677 (pl. II, b~c). The enamel is about 80μm thick and is differentiated primarily into an inner layer (portio interna, PI) and an outer layer (portio externa, PE). There is a very thin surface layer, which lacks prism. The PI consists of decussated prisms and layered prisms, the Hunter Schreger bands (HSB), and the PE comprises radial enamel. The PI is thicker than PE. Each prism is surrounded by the interprismatic matris (IPM). In a SEM image with higher magnification (not shown here), the crystallites are oriented roughly parallel to the prisms. In the longitudinal section the HSB has a small inclination angle, about 5° leaning anteriorly, to the enamel dentine junction. Each HSB usually contains three rows of prisms; some have less or more. The inclination of prisms in the PE is less than 45°. The enamel type is pauciserial.

Cheek teeth are low-crowned. Only two upper cheek teeth (left P4 and M2) are discovered, which are preserved in association with lower teeth (V 12674, holotype). The P4 is so identified because it is less worn than M2 and associated lower molars. The roots of the left P4 were not preserved, but the crown of the tooth is in good shape except a crack running between the paracone and metacone (pl. I, d). The tooth is wider than long (measurements in Table 1) and is longer labially than lingually. The protocone is a robust cusp and bears a small wear facet at its tip. The anterior cingulum is well developed; it starts anterodorsal to the protocone and extends to the anterolabial corner of the tooth. The cingulum flares labially and terminates as an inflated ridge, suggesting a parastyle. On the labial side of the tooth, the paracone and metacone are distinct, although their bases are not fully separated. Both cusps are strong, with the paracone being slightly larger. The labial surfaces of the paracone and metacone are smooth and rounded. The tip of each of the labial cusps bears a small wear facet. There is no external cingulum labial to the two cusps. Unlike M2, there is no mesostyle on P4. The crest connecting the paracone and protocone (protoloph) is low. In anterior view, the outline of the crest convex dorsally. There is no indication of a protoconule. The crest connecting the metacone and the protocone (metaloph) is stronger and longer than the protoloph. A swelling on the crest, which also bears a small wear facet, suggests a metaconule. Posterior to the protocone is a step-like projection, which is not well separated from the protocone and may be called an incipient hypocone. From this projection the postcingulum extends to the posterolabial conner of the tooth. In contrast to the anterior cingulum the postcingulum gradually narrows labially. There is a short, longitudinal ridge connecting the postcingulum and the posterior side of the metacone, which is an unusual structure on ctenodactyloid cheek teeth.

M1 and M3 are not preserved, but the impression of M1 is left on the matrix between P4 and M2, which helps to identify the M2. Similar to the condition of P4, roots of M2 are broken. The left M2 is more quadrate than P4 (pl. I, e). The anterior cingulum is broader than that of P4 and ends labially as a parastyle. A valley is formed between the low cingulum and the high protoloph, which separates the parastyle from the paracone labially. The protocone is robust and bears a wear facet that is deeper than that on the protocone of P4. The paracone has three surfaces defined by three ridges: one extends to the parastyle, one to the mesostyle and the other to the protocone (protoloph). The external surface of the paracone is convex, whereas those anterior and posterior to the protoloph are flat, inclined, and transversely extended. The protoloph is slightly curved, but is roughly perpendicular to the anteroposterior axis of the tooth. A small mesostyle is between the paracone and metacone. The metacone is smaller than the paracone. The metaloph is as wide as the metacone; it extends to the protocone but only narrowly

merges with the protocone. A small wear facet on the metaloph indicates presence of the metaconule. The hypocone is strong, but is smaller and slightly more labially positioned than the protocone. The postcingulum is strong, reaching to the posterior side of the metacone.

The medial half of the right p4 on the holotype was broken, but it is still clear that its talonid is wider than the trigonid and that the hypoconid is distinct. The p4 of V 12677 is complete (pl. II, d). It has two anteroposteriorly positioned roots. The metaconid is pointed and is the highest cusp of the tooth. It is much anteriorly located than the protoconid. The trigonid cusps are separated by a longitudinal groove. Both cusps are strong and their posterior surface forms a gently concave surface sloping posteriorly. There is no precingulid. The talonid is shorter than the trigonid and bears three cusps. The entoconid is conical and is the highest cusp of the talonid. The hypoconulid is anteroposteriorly compressed to form a transverse ridge. The hypoconid is low and robust. The p4 differs from molars in having more rounded anterior surface, a smaller hypoconulid, and a narrower trigonid.

The m1 trigonid is slightly wider than that of p4 (pls. I, f; II, a, b, d). Its anterior surface is flat because of the contact with the p4. The metaconid is the highest cusp on m1, but is lower than that of p4. The anteroposteriorly orientated trigonid basin is narrow and is anteriorly closed by a low ridge. The ectolophid is low, bearing a weak mesoconid when unworn; with wear the mesoconid is gone. The entoconid remains the same size as that on p4, but the hypoconulid and hypoconid are larger. The entoconid and hypoconid are teardrop-shaped, with the narrow end merging to the anterior base of the hypoconulid. The hypolophid is weak.

The m2 is significantly larger than m1 (pls. I, g; II, a~c). The posterior arm of the protoconid is blunt and incomplete, closing only the labial part of the trigonid basin posteriorly. The ectolophid is low but thick, and bears a weak mesoconid. The m3 is the largest, at least the longest, cheek tooth (pls. I, g; II, a~b, e~f). Its metaconid is more anteriorly extended than those of other cheek teeth. The hypoconid is massive, with rounded posterolateral surface. The hypoconulid is ridge-like; after wear it is incorporated in a strong, curved posterior ridge that extends from the hypoconid to the entoconid. The hypolophid is absent or weak. There are some other variations among specimens of m3 in our collection. The m3 of V 12679 has a small cusp labial to the ectolophid, which bears

Table 1 Measurements (mm)

Specimen	Tooth	Length	Width
V 12674 Holotype	LP4	2.03	2.97
	LM2	2.44	2.92
	Lm1	2.36	2.00
	Rm2	2.72	2.33
	Rm3	3.23	2.34
V 12675 right mandible	m1	2.42	1.95
with m1–m3	m2	2.89	2.28
	m3	3.16	2.29
V 12676 left mandible	m1	2.09	1.84
with m1–m3	m2	2.80	2.20
	m3	3.28	2.36
V 12677 right mandible	p4	2.40	1.88
with p4–m1	m1	2.31	1.94
V 12678 left mandible	m2	2.89	2.40
V 12679 left mandible	m3	3.45	2.52
V 12680 right mandible	m3	3.49	2.53

a flat wear facet (pl. II, e). The m3 of V 12675 bears a small cusp anterior to the entoconid (pl. II, a). After wear, the crown pattern is obscured, but the metaconid remains the highest cusp on all molars, as shown in V 12676. The hypolophid is absent on V 12680 (pl. II, f). The measurements of the teeth are given in Table 1.

The angular process is roughly in the same plane of the incisor, as shown in V 12679 (mandible not illustrated). On the holotype (V 12674), a single mental foramen is ventral to the anterior part of the p4 on the right mandible, whereas two foramina at the same position are on the left mandible. A single mental foramen is present on the mandible of V 12677 (pl. II, j). The masseteric fossa is broad and its anterior edge levels with the trigonid of m2. The rostrum is deep and short (pl. II, g~ h). The infraorbital canal is probably large, judged from the partial rostrum of V 12682, but its exact size cannot be determined because of breakage.

4 Comparison and discussion

In reviewing the complicated history in the study of Eocene ctenodactyloids, Averianov (1996) recognized two families, Chapattimyidae and Tamquammyidae, among ctenodactyloids. According to Averianov, Yuomyidae (Dawson et al., 1984; Flynn et al., 1986) is a junior synonym of Chapattimyidae Hussain et al., 1978, and Cocomyidae (de Bruijn et al., 1982; Dawson et al., 1984; Li et al., 1989; Dashzeveg, 1990a) and Oromomyidae (Dashzeveg, 1990b) are junior synonyms of Tamquammyidae Shevyreva, 1983. The similarities between Yuomyidae and Chapattimyidae were also recognized by Wang (1994). Tong (1997), however, placed Eocene ctenodactyloids into five families: Cocomyidae, Tamquammyidae, Tataromyidae, Yuomyidae and Chapattimyidae. The Cocomyidae is a monotypic family containing only *Cocomys*, a conception used by Flynn et al. (1986). The Eocene member of Tataromyidae includes one genus, *Prototataromys*, described by Tong in the same paper. Comparing the classifications used by Averianov and Tong, it is clear that Averianov's Chapattimyidae is roughly equivalent to Tong's Yuomyidae and Chapattimyidae, with the exception of *Euboromys* (Dashzeveg, 1990a; Dashzeveg and McKenna, 1991), *Dianomys* (Wang, 1984), and five genera described by Tong (1997). Averianov regarded the systematic position of *Euboromys* as uncertain. With *Cocomys* being excluded and placed in Cocomyidae, Tong's Tamquammyidae further differs from that of Averianov's in that *Orogomys* (Dashzeveg, 1990b) is not included and that *Tsagamys, Bumbanomys, Sharomys, Kharomys,* and *Ulanomys,* are recognized as valid taxa. Averianov (1996) considered that *Bumbanomys, Sharomys, Kharomys,* and *Ulanomys,* as junior synonyms of *Tsagankhushumys* Shevyreva, 1989, but did not mention the systematic position of *Tsagamys*. Judging from the context in which Averianov considered all small tamquammyids from the Tsagan Khushu, it seems that *Tsagamys* may also be a synonym of *Tsagankhushumys*. In addition, Tong's Tamquammyidae include two new taxa, *Viriosomys* and *Chuankueimys*. Tong believed that cheek teeth of Yuomyidae and Chapattimyidae are still distinguishable. According to Tong, the P4 of chapattimyids is nearly quadrate, precingulum narrow, hypocone small, cheek teeth cusps round, p4 relatively small, and the ectolophid commonly curving laterally. Those from South Asia have low-crowned teeth with enamel wrinkles. In contrast, cheek teeth of some yuomyids have certain degree of unilateral (lingual) hypsodonty and smooth enamel surface; P4 is in higher degree of molarization with large hypocone and ear-shaped precingulum; p4 are well-developed, often larger than m1; and the ectolophid on cheek teeth is straight. In the classification by McKenna and Bell (1997), however, all ctenodactyloids are included in the family Chapattymyidae.

Averianov (1996) provided diagnoses of Chapattimyidae and Tamquammyidae, which

are either emended or adopted from Dawson et al. (1984). When these diagnoses are compared, the two families are distinguished from each other primarily on their P4 / p4 morphologies. Other features are partly overlapped, such as the hystricomorphy, in both families. Therefore, the diagnoses of the two families essentially mirror the conclusion reached by Dawson et al. (1984: 149) that "[t] wo distinct lines of ctenodactyloids, here recognized as the two families Cocomyidae and Yuomyidae, are present in the Eocene. The major distinctions between these families are in the structure of P4/4. The Cocomyidae have non-molariform P4/4, which appears to be the primitive rodent condition, and which characterizes as well the Ctenodactylidae, probably descendants of the Cocomyidae. In the Yuomyidae P4 / 4 are sub-molariform, and this family also developed lophate cheek teeth reminiscent of those in cylindrodontids."

Given that the non-molariform P4/4 is a primitive feature, the family Chapattimyidae (sensu Averianov, 1996) are therefore not diagnosed by any unique and derived character. The paraphyletic nature of each family has been demonstrated by phylogenetic analyses of selected ctenodactyloids (Averianov, 1996; Dashzeveg and Meng, 1998), in which neither of the two families is recognized as a clade.

A. ulungurensis can be distinguished from tamquammyids, *Cocomys*, and *Prototataromys* in having submolariform P4 / p4. In this regard, it should be noted that *Butomys* has a non-molariform p4, although it was purposely not assigned to a family (Dashzeveg and Meng, 1998). Similarly, *Mergenomys* (Dashzeveg and Meng, 1998) was not placed in a family, but it is closely related to the Tataromyidae.

A. ulungurensis is similar to chapattimyids (sensu Averianov, 1996) in having submolariform P4 / p4. Among chapattimyids *A. ulungurensis* differs from the South Asian Eocene species by the features outlined by Tong (1997), as mentioned in the preceding sections. *Yuomys* and *Petrokozlovia*, which were placed in a subfamily Yuomyinae Tong, 1997, differ from *A. ulungurensis* in having higher tooth crown and more lophate cheek teeth. Because of their lophate teeth, these two taxa were found similar to cylindrodonts (Li, 1975; Hussain et al., 1978; Dawson et al., 1984; Averianov, 1996). Other Eocene ctenodactyloids that were placed in a new subfamily, Stelmomyinae Tong, 1997, include *Stelmomys*, *Advenimus*, *Saykanomys*, *Chkhikvadzomys*, *Bolosomys*, *Geitonomys*, ?*Esesempomys*, *Euboromys*, *Hohomys*, *Badaomys*, and *Xueshimys*. These taxa were further divided into two morphotypes: one with well-developed cusps on upper cheek teeth and presence of the mesoconid on the lower molars; the other with short, wide p4, absence of the mesoconid. *Advenimus*, *Saykanomys*, *Chkhikvadzomys*, *Hohomys*, *Badaomys*, and probably *Geitonomys* were type one taxa, whereas *Stelmomys*, *Euboromys*, and *Xueshimys* are type two taxa. *Bolosomys*, *Geitonomys*, and? *Esesempomys* cannot be assigned to either type because of poor materials.

Stelmomys and *Xueshimys* are significantly smaller than *A. ulungurensis*. The ectolophid on the lower molars of the two genera is incomplete; it terminates posterior to the posterior wall of the trigonid. In *A. ulungurensis*, although a mesoconid is weak, the ectolophid is complete and merges with the posterior wall of the trigonid. Moreover, cheek teeth of *Stelmomys* and *Xueshimys* are more cuspate than those of *A. ulungurensis*.

The systematic position of *Euboromys* (Dashzeveg, 1990a; Dashzeveg and McKenna, 1991) remains uncertain, as pointed out by Averianov (1996). As the specific name implies, *Euboromys grandis* is the largest ctenodactyliod from the Tsagan Khushu area. It is based solely on the holotype, a fragmentary mandible with dp4-m2, although upper teeth were mentioned when comparisons were made between *Euboromys* and *Chkhikvadzomys* (Dashzeveg, 1990a). Dashzeveg (1990a) considered *Advenimus* the nearest related genus of *Euboromys* and particularly compared *Euboromys* with cf. *Advenimus* sp. from Chimney Butte, Shara Murun region of Nei Mongol (Dawson, 1964). Three fragmentary lower jaws

(AMNH 26291–3) were referred to as cf. *Advenimus* sp. by Dawson, who was uncertain about the taxonomic assignment of these specimens and pointed out that these specimens were also similar to a m3 identified as *Sciuravus* sp. by Li (1963). More recently, Tong (1997) described two species of *Euboromys* based on isolated teeth from the middle Eocene Hetaoyuan Formation, Xichuan County of Henan Province, China. These species are much smaller than *Euboromys grandis* (Dashzeveg, 1990a). *Euboromys grandis* differs from the Yuanqu specimens in that the lower molars are quadrate in crown view, with a distinct ectolophid located along the longitudinal axis of the molars, and a deep hypoflexid between the protoconid and hypoconid. Tong (1997) considered the p4 of *E. obtusus* (the holotype is a p4, which was not illustrated) is similar to that of *Euboromys grandis*, but the latter was a dp4 (Dashzeveg, 1990a). Tong also regarded cf. *Advenimus* sp. (Dawson, 1964) a species of *Euboromys*, and named it *E. marydawsonae*, pointing AMNH 26291 as the holotype of the species. In our view, however, AMNH 26291–3 are more lophate than *Euboromys grandis*, *E. obtusus* and *E. brachyblastus*. They certainly belong to the same species, which may be placed in a different genus from *Advenimus*, but probably not in *Euboromys*. The well-developed hypolophid that extends to the ectolophid on these specimens also differ them from those of *A. ulungruensis*.

When it was originally proposed *Advenimus* included *A. burkei* (type species), *A. bohlini* and cf. *Advenimus* sp. (Dawson, 1964). Dawson et al. (1984) suggested that *Saykanomys* Shevyreva (1972, 1976) is a synonym of *Advenimus*. Dashzeveg (1990a) regarded *Saykanomys* a synonym of *Advenimus*. Specifically, he regarded *S. chalchae* as synonym of *A. bohlini*. The synonym of *Saykanomys* with *Advenimus* was supported by Kumar et al. (1997). Averianov (1996) considered *Saykanomys* a valid genus but considered *A. bohlini* a synonym of *S. chalchae* and therefore the type species of *Saykanomys*. Tong (1997) also regarded *Saykanomys* as a valid genus and *S. bohlini* the type species of the genus. Tong pointed out that *Saykanomys* differs from *Advenimus* in the following features: lower cheek teeth with higher crown and more pointed cusps, p4 hypoconulid closer to the entoconid, m1–2 hypoconulid more conical and in center of the posterior edge of the tooth instead of more labially positioned, and the medial and lateral crest (postcingulum) from the hypoconulid equally developed. These features also differ *A. ulungurensis* from species of *Saykanomys*.

A. ulungurensis is most similar to *Advenimus burkei* (Dawson, 1964) and *A. hupeiensis* (Dawson et al., 1984) in general morphology. *A. ulungurensis* is more similar to *Advenimus hupeiensis* in having cheek teeth proportionally wider, p4 as large as m1, p4 talonid wider than trigonid, and the entoconid not strongly crested. *A. ulungurensis* differs from *Advenimus burkei* in having talonid wider than trigonid and the absence of a precingulum on p4; more blunt cusps, more anterioly leaning metaconid, the hypolophid being less–developed and extended to the anterior base of the hypoconulid (on m2–3 of the type specimen of the *Advenimus burkei* [AMNH 26664], the hypolophid extends anterolaterally to the ectolophid anteromedial to the hypoconid), the smaller mesoconid, and the more open talonid basin. *A. ulungurensis* differs from *Advenimus hupeiensis* in having less bulbous cusps on cheek teeth, the more anteriorly extended metaconid, the weaker posterior arm of the protoconid, the smaller mesoconid, and the stronger hypoconid–hypoconulid connection.

Advenimus burkei and *A. hupeiensis* are represented only by lower jaws and dentitions, which makes further comparison with *A. ulungurensis* impossible. Some upper and lower teeth, either isolated or in fragmentary maxilla and mandible, collected from lower Eocene of Kyrgyztan, were assigned to *Advenimus* cf. *A. burkei* (Averianov, 1996). It was not clear how these isolated upper and lower teeth were clustered as if they were from the

same species. Nonetheless, the P4 (Averianov, 1996, ZIN C.81118, fig.4E) is similar to V 12674 of *A. ulungurensis* in having a distinct precingulum and closely spaced paracone and metacone. It differs from the P4 of *A. ulungurensis* in having a stronger hypocone and in being transversely narrower. Another P4 described by Averianov (1996, ZIN C. 81130, fig.5E) appears different from ZIN C.81110 in being more round. The dP4 from Kyrgyztan is molariform, with square-shaped crown, separated paracone and metacone, and well-developed metaconule. The lower cheek teeth from Kyrgyztan differ from those of *A. ulungurensis* in that the hypolophid is directed to the hypoconid.

5 Age determination

The specimens described here as *A. ulungurensis* were collected from a set of light colored fluviallacustrine sediments named the "Ulunguhe" (Ulungur-he, meaning Ulungur-River) Formation near the Halamagai Village by the Xinjiang Geological Survey (Tong et al., 1987[1], 1990). The type locality and section of the formation were not originally specified, but were later considered to be in the Ulungur River area and were most likely located near the Halamagai area (Tong et al., 1987, 1990). Therefore, the beds yielding the spcimens of *A. ulungurensis* were probably the type locality of the "Ulunguhe" Formation. The age of the formation has been controversial. It was previously believed to be the Oligocene, Eocene and Oligocene collectively, or Cretaceous (Wu, 1973; Peng 1975; Tong et al., 1987, 1990) (see Ye et al., 2000 for additional discussion). The discovery of *A. ulungurensis* shows that the "Ulunguhe" Formation containing the fossils in the Halamagai area is of Eocene in age.

Advenimus burkei was originally recorded as from the "Irdin Manha" Formation near Camp Margetts (Dawson, 1964). Qi (1987) listed these specimens as from Arshanto beds at the Camp Margetts area (see Radinsky, 1964; Meng, 1990). By faunal correlations, the Arshantan land mammal age of Asia is considered to be early Middle Eocene and the Irdinmanhan middle Middle Eocene in age (Meng and McKenna, 1998). Even earlier age determinations of these units remain possible if the Paleocene-Eocene boundary, currently drawn between the Gashatan and Bumbanian, shifts upward (Beard, 1998; Meng et al., 1998).

Advenimus hupeiensis comes from the middle part of the Yuhuangding Formation, Dajian village, Hubei Province of China. The fauna coexisting with *A. hupeiensis* includes *Rhombomylus* cf. *R. turpanensis*, cf. *Heptondon* sp., *Asiocoryphodon conicus*, *Heterocoryphdon flerowi*, *Chungchienia sichuanensis* and *Hohomys lii*. The age of the fauna is believed to be late Early Eocene (Li and Ting, 1983; Ma and Cheng, 1991; Hu, 1995).

Advenimus cf. *A. burkei* from Kyrgyzstan is also of Early Eocene in age (Averianov, 1996). Because the mammal fossils are found in marine coastal sediments and are in association with abundant chondrichthyan fishes, the faunal correlation is more reliable than that using only mammal fossils.

Given the geological distributions of *Advenimus*, we tentatively estimate the age of the beds yielding *A. ulungurensis* to be late early Eocene. It is not surprise to discover *A. ulunguensis* in northern Xinjiang, because other species of the genus were found to the east, south and west of the area.

Acknowledgements We thank Bi Shundong, Wu Shaoyuan, Fan Guizhong, and Su Jianfeng for field assistance. We thank K. Fischmann for taking the SEM photographs in pl. I.

1) Tong Y S (童永生), Qi T (齐陶), Ye J (叶捷) et al., 1987. Tertiary beds and fossils from north Junggar Basin, Xinjiang Province. In: Fossil vertebrates and stratigraphy of Xinjiang. Academia Sinica. 1~61

Professor Li Chuankuei of the IVPP made useful comments on the manuscript. This research has been supported by grants from the Chinese National Natural Science Foundation (49572080, 49928202) and Chinese Ministry of Sciences and Technology ([1999] 045). Meng's research is also supported by NSF grant (DEB-9796038).

References

Averianov A, 1996. Early Eocene Rodentia of Kyrgyzstan. Bull Mus nat d'Hist nat paris, 4ᵉ sér, **18C**:629～662

Beard K C, 1998. East of Eden: Asia as an important center of taxonomic origination in mammalian evolution. Special volume of the Symposium on Cretaceous and early Tertiary mammals of Asia. Bull Carneg Mus, **34**: 5～39

Bruijn H de, Hussain S T, Leinders J J M, 1982. On some Early Eocene rodent remains from Barbara Banda, Kohat, Pakistan, and the early history of the order Rodentia. Proc Konink Nederl Akad Wetensch, **B85**(3): 249～258

Dashzeveg D, 1990a. The earliest rodents (Rodentia, Ctenodactyloidea) of Central Asia. Acta Zool Cracov, **33**(2): 11～35

Dashzeveg D, 1990b. New trends in adaptive radiation of early Tertiary rodent (Rodentia, Mammalia). Acta Zool Cracov, **33**(3):37～44

Dashzeveg D, McKenna M C, 1991. *Euboromys*, a new name for the Eocene rodent *Boromys* Dashzeveg, 1990, not *Boromys* Miller, 1916. J Vert Paleont, **11**(4):527

Dashzeveg D, Meng J, 1998. New Eocene ctenodactyloid rodents from the Eastern Gobi Desert of Mongolia and a phylogenetic analysis of ctenodactyloids based on dental features. Am Mus Novit, (3246):1～20

Dawson M R, 1964. Late Eocene rodents (Mammalia) from Inner Mongolia. Am Mus Novit, (2191):1～15

Dawson M R, Li C K, Qi T, 1984. Eocene ctenodactyloid rodents (Mammalia) of Eastern and Central Asia. In: Mengel R M ed. Papers in vertebrate paleontology honoring Robert Warren Wilson. Carneg Mus Nat Hist Sp Publ, **9**:138～150

Flynn L J, Jacobs L L, Cheema I U, 1986. Baluchimyinae, a new ctenodactyloid rodent subfamily from the Miocene of Baluchistan. Am Mus Novit, (2841):1～50

Hu Y M (胡耀明), 1995. New Late Early Eocene ctenodactyloid rodents (Rodentia, Mammalia) from Danjiangkou, Hubei. Vert PalAsiat (古脊椎动物学报), **33**(1):24～38(in Chinese with English summary)

Hussain S T, Bruijn H de, Leinders J J M, 1978. Middle Eocene rodents from the Kala Chitta Range (Punjab, Pakistan). Proc Konink Nederl Akad Wetensch, **B81**(1):74～112

Korth W W, 1984. Earliest Tertiary evolution and radiation of rodents in North America. Bull Carneg Mus Nat Hist, **24**:1～71

Kumar K, Srivastava R, Sahni A, 1997. Middle Eocene rodents from the Subathu Group, Northwest Himalaya. Palaeovertebrata, **26**(1～4):83～128

Li C K (李传夔), 1963. Paramyid and sciuravid from North China. Vert PalAsiat (古脊椎动物学报), **7**(2):151～160 (in Chinese with English summary)

Li C K (李传夔), 1975. *Yuomys*, a new ischyromyid rodent genus from the upper Eocene of North China. Vert PalAsiat (古脊椎动物学报), **13**(1):58～70 (in Chinese with English summary)

Li C K, Ting S Y, 1983. The Paleogene mammals of China. Bull Carneg Mus, **21**:1～98

Li C K, Zheng J J, Ting S Y, 1989. The skull of *Cocomys lingchaensis*, an Early Eocene Ctenodactyloid rodent of Asia. In: Black C et al. eds. Papers on fossil rodents. In honor of Albert Elmer Wood. Science Series. Nat Hist Mus Los Angeles County, **33**:179～192

Ma A C (马安成), Cheng J (程捷), 1991. On biostratigraphical subdivision of Yuhuangding Formation in Liguanqiao Basin of eastern Qinling region. Sci Geol Sin (地质科学), **16**:21～29 (in Chinese with English summary)

McKenna M C, Bell S K, 1997. Classification of mammals above the species level. New York: Columbia

University Press. 1～161

Meng J (孟津), 1990. A new species of Didymoconidae and comments on related locality and stratigraphy. Vert PalAsiat (古脊椎动物学报), **28**(3): 206～217 (in Chinese with English summary)

Meng J, McKenna M C, 1998. Faunal turnovers of Palaeogene mammals from the Mongolian Plateau. Nature, **394**: 364～367

Meng J, Zhai R J, Wyss A R, 1998. The late Paleocene Bayan Ulan fauna of Inner Mongolia, China. Special volume of the Symposium on Cretaceous and early Tertiary mammals of Asia. Bull Carneg Mus, **34**: 148～185

Peng X L (彭希龄), 1975. Cenozoic vertebrate localities and horizon of Dzungaria Basin, Sinkiang. Vert PalAsiat (古脊椎动物学报), **13**(3): 185～189 (in Chinese)

Peng X L (彭希龄), Wu S Z (吴绍祖), 1983. Vertebrate fossil beds from Xinjiang and discussion on related problems. Xinjiang Geol (新疆地质), **1**: 44～58(in Chinese)

Qi T, 1987. The Middle Eocene Arshanto fauna (Mammalia) of Inner Mongolia. Ann Carneg Mus, **56**(10): 1～73

Radinsky L B, 1964. Notes on Eocene and Oligocene fossil localities in Inner Mongolia. Am Mus Novit, (2180): 1～11

Shevyreva N S, 1972. New rodents from the Paleogene of Mongolia and Kazakhstan. Paleont Zhur, **3**: 134～145 (in Russian)

Shevyreva N S, 1976. Paleogene rodents of Asia (Families Paramyidae, Sciuravidae, Ischyromyidae, Cylindrodontidae). Trans Paleont Inst Acad Sci, USSR, **158**: 1～115 (in Russian)

Shevyreva N S, 1983. New rodents from the Early Eocene of Zaaltay Gobi (Mongolia). In: Gromov I M ed. Gruzuny. Materialy IV vseoyuznogo soveshchania. Leningrad: Nauka. 55～58 (in Russian)

Shevyreva N S, 1984. New Early Eocene rodents of the Zaysan Basin. In: Gabunia L K ed. The Flora and Fauna of the Zaysan Basin. Tbilisi: Metsniyerebs Press. 77～114 (in Russian)

Shevyreva N S, 1989. New rodents (Ctenodactyloidea, Rodentia, Mammalia) from the Lower Eocene of Mongolia. Paleont Zhur, 3: 60～72 (in Russian)

Tong Y S (童永生), 1997. Middle Eocene small mammals from Liguanqiao Basin of Henan Province and Yuanqu Basin of Shanxi Province, Central China. Pal Sin (中国古生物志), N S C, **26**: 1～256 (in Chinese with English summary)

Tong Y S, Dawson M R, 1994. Early Eocene rodents (Mammalia) from Shandong Province, People's Republic of China. Ann Carneg Mus, **64**(1): 51～63

Tong Y (童永生), Qi T (齐陶), Ye J (叶捷) et al., 1990. Tertiary stratigraphy of the north of Junggar Basin, Xinjiang. Vert PalAsiat (古脊椎动物学报), **28**(1): 59～70 (in Chinese with English summary)

Wang B Y, 1984. *Dianomys* gen. nov. (Rodentia, Mammalia) from the lower Oligocene of Quijing, Yunnan, China. Mainzer geowiss Mitt, **13**: 37～48

Wang B Y, 1994. The Ctenodactyloidea of Asia. In: Tomida Y, Li C K, Setoguchi T eds. Rodent and lagomorph families of Asian origin and diversification. Nat Sci Mus Monogr, Tokyo, **8**: 35～47

Wang B Y, 1997. The mid-Tertiary Ctenodactylidae (Rodentia, Mammalia) of Eastern and Central Asia. Bull Am Mus Nat Hist, **234**: 1～88

Wei J M (魏景明), Tong Y S (童永生), 1992. The discovery of Paleocene and Eocene deposits in the northern Junggar Basin. Acta Petrolei Sin (石油学报), **13**: 117～120 (in Chinese)

Wood A E, 1977. The evolution of the rodent family Ctenodactylidae. J Palaeont Soc India, **20**: 120～137

Wu S Z (吴绍祖) 1973. The discovery of *Yaxartosaurus* sp. from Sinkiang. Vert PalAsiat (古脊椎动物学报), **11**(4): 217～218 (in Chinese)

Ye J (叶捷), Wu W Y (吴文裕), Meng J (孟津) et al., 2000. New results in the study of Tertiary biostratigraphy in the Ulungur River Region of Xinjiang, China. Vert PalAsiat (古脊椎动物学报), **38**(3): 192～202

Professor Li Chuankuei of the IVPP made useful comments on the manuscript. This research has been supported by grants from the Chinese National Natural Science Foundation (49572080, 49928202) and Chinese Ministry of Sciences and Technology ([1999] 045). Meng's research is also supported by NSF grant (DEB-9796038).

References

Averianov A, 1996. Early Eocene Rodentia of Kyrgyzstan. Bull Mus nat d'Hist nat paris, 4e sér, **18C**: 629～662

Beard K C, 1998. East of Eden: Asia as an important center of taxonomic origination in mammalian evolution. Special volume of the Symposium on Cretaceous and early Tertiary mammals of Asia. Bull Carneg Mus, **34**: 5～39

Bruijn H de, Hussain S T, Leinders J J M, 1982. On some Early Eocene rodent remains from Barbara Banda, Kohat, Pakistan, and the early history of the order Rodentia. Proc Konink Nederl Akad Wetensch, **B85**(3): 249～258

Dashzeveg D, 1990a. The earliest rodents (Rodentia, Ctenodactyloidea) of Central Asia. Acta Zool Cracov, 33(2): 11～35

Dashzeveg D, 1990b. New trends in adaptive radiation of early Tertiary rodent (Rodentia, Mammalia). Acta Zool Cracov, 33(3): 37～44

Dashzeveg D, McKenna M C, 1991. *Euboromys*, a new name for the Eocene rodent *Boromys* Dashzeveg, 1990, not *Boromys* Miller, 1916. J Vert Paleont, **11**(4): 527

Dashzeveg D, Meng J, 1998. New Eocene ctenodactyloid rodents from the Eastern Gobi Desert of Mongolia and a phylogenetic analysis of ctenodactyloids based on dental features. Am Mus Novit, (3246): 1～20

Dawson M R, 1964. Late Eocene rodents (Mammalia) from Inner Mongolia. Am Mus Novit, (2191): 1～15

Dawson M R, Li C K, Qi T, 1984. Eocene ctenodactyloid rodents (Mammalia) of Eastern and Central Asia. In: Mengel R M ed. Papers in vertebrate paleontology honoring Robert Warren Wilson. Carneg Mus Nat Hist Sp Publ, **9**: 138～150

Flynn L J, Jacobs L L, Cheema I U, 1986. Baluchimyinae, a new ctenodactyloid rodent subfamily from the Miocene of Baluchistan. Am Mus Novit, (2841): 1～50

Hu Y M (胡耀明), 1995. New Late Early Eocene ctenodactyloid rodents (Rodentia, Mammalia) from Danjiangkou, Hubei. Vert PalAsiat (古脊椎动物学报), **33**(1): 24～38(in Chinese with English summary)

Hussain S T, Bruijn H de, Leinders J J M, 1978. Middle Eocene rodents from the Kala Chitta Range (Punjab, Pakistan). Proc Konink Nederl Akad Wetensch, **B81**(1): 74～112

Korth W W, 1984. Earliest Tertiary evolution and radiation of rodents in North America. Bull Carneg Mus Nat Hist, **24**: 1～71

Kumar K, Srivastava R, Sahni A, 1997. Middle Eocene rodents from the Subathu Group, Northwest Himalaya. Palaeovertebrata, **26**(1～4): 83～128

Li C K (李传夔), 1963. Paramyid and sciuravid from North China. Vert PalAsiat (古脊椎动物学报), 7(2): 151～160 (in Chinese with English summary)

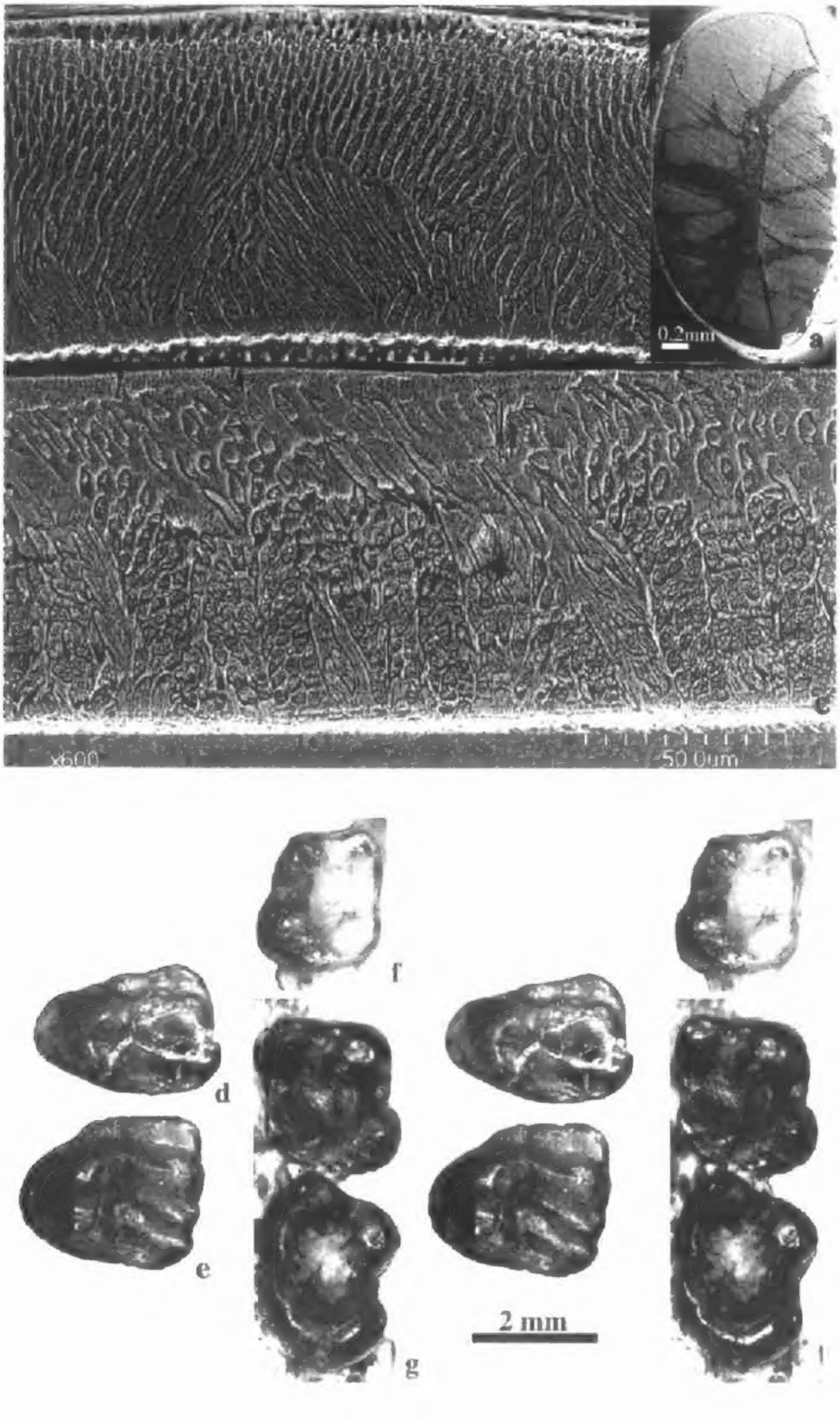
Li C K (李传夔), 1975. *Yuomys*, a new ischyromyid rodent genus from the upper Eocene of North China. Vert PalAsiat (古脊椎动物学报), 13(1): 58～70 (in Chinese with English summary)

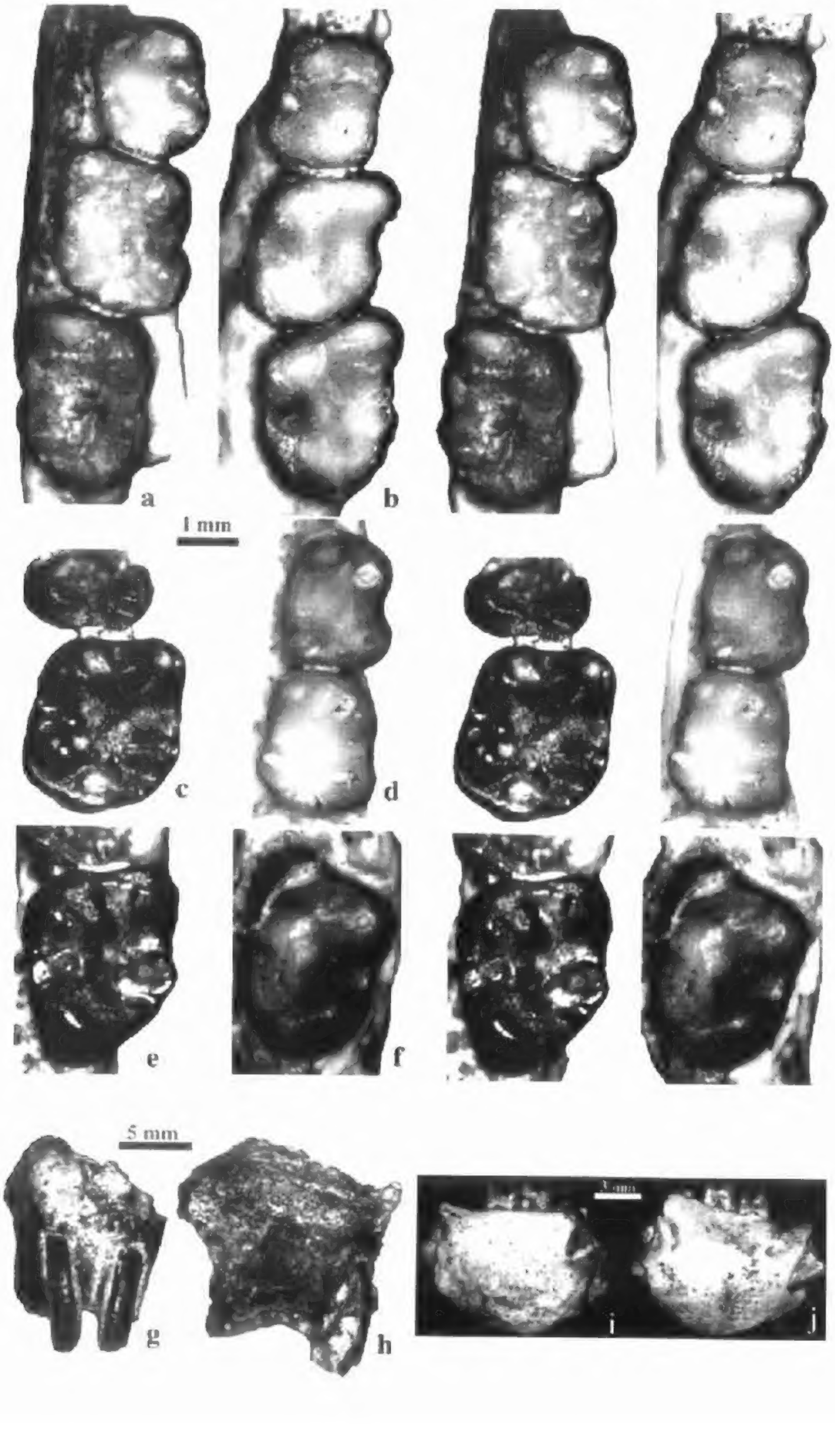
Li C K, Ting S Y, 1983. The Paleogene mammals of China. Bull Carneg Mus, **21**: 1～98

Li C K, Zheng J J, Ting S Y, 1989. The skull of *Cocomys lingchaensis*, an Early Eocene Ctenodactyloid rodent of Asia. In: Black C et al. eds. Papers on fossil rodents. In honor of Albert Elmer Wood. Science Series. Nat Hist Mus Los Angeles County, **33**: 179～192

Ma A C (马安成), Cheng J (程捷), 1991. On biostratigraphical subdivision of Yuhuangding Formation in Liguanqiao Basin of eastern Qinling region. Sci Geol Sin (地质科学), **16**: 21～29 (in Chinese with English summary)

McKenna M C, Bell S K, 1997. Classification of mammals above the species level. New York: Columbia


0.2mm
a
c
x600
50.0um
f
d
e
g
2 mm


a
b
1 mm
c
d
e
f
5 mm
g
h
i
j